PCB MOUNTABLE STAGGERED TERMINAL BLOCK

BACKGROUND OF THE INVENTION

Field of Invention

[0001] The invention relates generally to the field of terminal blocks for printed circuit boards and, more specifically, to a terminal block with a housing arranged to enable the screw heads of the terminal block to be turned by a standard installer screwdriver.

[0002] Description of Related Art

[0003] Installers of electrical systems carry an industry standard flat blade screwdriver, also known as a pocket screwdriver. The blade width of this screwdriver is approximately 1/8 inch (3.175 mm). Electrical devices are electrically connected together with wires. These wires are connected to the circuit boards of electronic devices via terminal blocks. These terminal blocks contain screws which clamp down on the wires as the screws are tightened with these industry standard screw drivers. Electronic devices are getting smaller as the electronics industry advances. Miniature printed circuit board (PCB) mounted terminal blocks (3.5mm centerline spacing) are being used more often in these smaller electronic devices. The industry standard screwdriver is too wide to be used with the small screws in the miniature terminal blocks. The screw head size in the current miniature terminal blocks can not be increased without interfering with the neighboring screw or increasing the length of the terminal block. The

next size larger terminal block (5mm centerline spacing) does accept the industry standard screw driver. However it is 43% longer, 10% wider and 18% taller. In many applications, the larger size terminal block can not be accommodated.

[0004] However, use of the smaller blade width screwdriver can result in inadequate torque and consequently in inadequate and poor quality electrical connections. As a result, use of the industry standard blade width screwdriver is strongly preferred by the installers.

[0005] What is needed is a smaller size terminal block to accommodate the trend to miniaturization of the electronic parts and which permits, at the same time, use of an industry standard blade width screwdriver to make the electrical connections.

SUMMARY OF THE INVENTION

[0006] To address the above and other issues, the present invention describes a technique for staggering the screw cavities of a miniature terminal block to decrease the size of PCBs while, at the same time, permits use of an industry standard installer's screwdriver for all styles or types of PCB mounting arrangements.

[0007] In a particular aspect of the invention, a printed circuit board (PCB) has a terminal block for coupling by screw-operated coupling means at least one conductor to the PCB, the terminal block comprising: a housing of insulating

material, the housing having at least one transverse opening capable of receiving at least one contact member for coupling the at least one conductor to the PCB, and at least two cavities disposed within the housing. The cavities are for accepting the screw-operated coupling means. The housing has a length-wise direction along a reference line, and the at least two cavities each has a center point. The center point of at least one of the at least two cavities is disposed in an offset position from the reference line in the length-wise direction such that the at least two cavities are staggered with respect to each other.

[0008] Another aspect of the present invention is a printed circuit board (PCB) mountable terminal block for coupling by screw-operated coupling means at least one conductor to a PCB. The terminal block comprises a housing. At least two cavities within the housing are for accommodating a screw of the screw-operated coupling means; and at least one transverse opening within the housing is capable of accommodating a contact member, the at least one transverse opening being capable of disposing the contact member on an end surface of the PCB such that the at least one conductor can be coupled to the PCB from the end surface. The housing has a length-wise direction along a reference line, the at least two cavities each having a center point, and the center point of at least one of the at least two cavities is disposed in an offset position from the reference line in the length-wise direction such that the at least two cavities are staggered with respect to each other.

[0009] Another aspect of the present invention is a printed circuit board (PCB) mountable terminal block for coupling by screw-operated coupling means at least one conductor to a PCB. The terminal block comprises a housing. At least two cavities within the housing are for accommodating a screw of a screw-operated coupling means; and at least one transverse opening within the housing is capable of accommodating a contact member. The housing has a length-wise direction along a reference line. The at least two cavities each has a center point, the center point of at least one of the at least two cavities being disposed in an offset position from the reference line in the length-wise direction such that the at least two cavities are staggered with respect to each other. The housing of the terminal block has a height enabling orientation of a length-wise direction of the terminal block transversely with respect to a longitudinal centerline direction of a larger housing enclosing the terminal block and the PCB

[0010] Still another aspect of the present invention is a terminal block for coupling by screw-operated coupling means for coupling at least one conductor to a printed circuit board. The terminal block comprises a housing of insulating material. The housing has at least one transverse opening capable of receiving at least one contact member for coupling the at least one conductor to the PCB, and at least two cavities are disposed within the housing. The cavities are for accepting the screw-operated coupling means. The housing has a length-wise direction along a reference line. The at least two cavities each has a center point. The center point of at least one of the at least two cavities is disposed in an offset

position from the reference line in the length-wise direction such that the at least two cavities are staggered with respect to each other.

[0011] In each of the foregoing aspects of the present invention, at least one of the at least two cavities has a diameter at least equal to the width of the blade of a standard installer screwdriver. A contact member can be disposed within at least one of the at least two cavities. The contact member comprises: an upper portion with a transverse opening, and a lower portion with a pin, and wherein the upper portion is threaded to accept a screw. The contact member can further comprise a screw with a head having a diameter at least equal to the width of the blade of a standard installer screwdriver.

[0012] The diameter of the at least one of the at least two cavities is at least equal to 0.125 inches (3.175 mm). The head of the screw has a diameter at least equal to 0.125 inches (3.175 mm). The contact member can further comprise a wire guard for guarding a conductor wire. The lower portion with a pin can be disposed to permit through hole mounting to a printed circuit board (PCB). The terminal block can comprise solder pads permitting surface mounting to a printed circuit board (PCB). The terminal block can be for coupling by screw-operated conductor-clamping terminal coupling means for coupling at least one conductor to a printed circuit board. Alternatively, the terminal block is for coupling by screw-operated insulation displacement terminal coupling means for coupling at least one conductor to a printed circuit board. The housing can comprise at least four transverse openings that can be disposed on an end surface of the PCB, the

openings each capable of accommodating at least one contact member for coupling a conductor to the PCB.

[0013] When the housing of the terminal block has a height enabling orientation of a length-wise direction of said terminal block transversely with respect to a longitudinal centerline direction of a larger housing enclosing the terminal block and the PCB, the larger housing can have an inner diameter of 1 inch (25.4 mm).

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] These and other features, benefits and advantages of the present invention will become apparent by reference to the following text and figures, with like reference numbers referring to like structures across the views, wherein:

[0015] FIG. **1A** shows a perspective view of a PCB mount terminal block of the prior art.

[0016] FIG. 1B shows a perspective view of a PCB mount staggered terminal block of the present invention.

[0017] FIG. **2A** shows a perspective view of the prior art terminal block of FIG. **1A** with respect to a standard installer screwdriver blade.

[0018] FIG. **2B** shows a perspective view of the terminal block of the present invention of FIG. **1B** with respect to the standard installer screwdriver blade.

[0019] FIG. **3A** shows a perspective view of the prior art terminal block with the components fully assembled.

[0020] FIG. **3B** shows a perspective view of the terminal block of the present invention with the components fully assembled.

[0021] FIG. **4A** is an exploded perspective view of the prior art terminal block.

[0022] FIG. **4B** is an exploded perspective view of the terminal block of the present invention.

[0023] FIG. **5A-1** is a plan view of the prior art terminal block.

[0024] FIG. **5A-2** is an elevation view of the prior art terminal block.

[0025] FIG. **5A-3** is a side elevation view of the prior art terminal block.

[0026] FIG. **5B-1** is a plan view of the terminal block of the present invention.

[0027] FIG. **5B-2** is an elevation view of the terminal block of the present invention.

[0028] FIG. **5B-3** is a side elevation view of the terminal block of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0029] The present invention describes a terminal block structure in which by alternately shifting each screw fore or aft (staggering), larger screw head diameters can be accommodated without increasing the length of the terminal block. The screw heads can be enlarged sufficiently to accept at least the 1/8" (3.175 mm) wide industry standard screwdriver or greater. The front face of the wire receptacle is recessed within the nonconductive housing to prevent the

exposed uninsulated portions of neighboring wires from contacting each other. By staggering the screws and associated wire receptacles, the same effect is achieved without increasing the width of the miniature terminal block. Therefore, within the same PCB foot-print used by a current miniature PCB mountable terminal block, this invention provides the installer a terminal block which will accept the industry standard screwdriver, and so result in high quality electrical connections even with reduced size terminal blocks.

[0030] This invention can be used in any application that currently employs a miniature PCB mountable terminal block and will provide the benefit of working with a larger range of screwdrivers. Although the embodiment of this invention shown in the attached illustrations contains pins for a "through hole" PCB attachment, an alternate embodiment can be made in a surface mount (SMD) configuration.

[0031] FIG. **1A** shows a perspective view of a PCB-mountable staggered terminal block of the prior art. The three-dimensional x-y-z axes are as shown. The x and y axes lie in the plane of the PCB with the x-axis oriented along the length of the terminal block and the z-axis normal to the plane of the PCB. Terminal block **100** is configured such that screw heads **102** are positioned in cavities **103.** The cavities **103** each have a center point **105**, which coincides with the center point of the screw heads **102.** The center points **105** are positioned linearly along a reference line **104** that is parallel to the x-axis. The terminal block **100** is shown here mounted on a PCB which projects from a nonconductive housing **108.** The

nonconductive housing **108** illustrated is a typically 1 inch (25.4mm) diameter enclosure, which protects the printed circuit board assembly of an acoustic glass-break detector. It can be appreciated from FIG. **1A** that the 3.5mm centerline spacing terminal block 104 shown does fit within the 1 inch (25.4 mm) diameter enclosure **108.** It can be appreciated that a larger 5mm centerline spacing terminal block which accepts the industry standard blade width screw driver would violate the 1 inch (25.4 mm) diameter enclosure. It is the small size of the enclosure that limits the size of the PCB assembly and creates the need for small terminal blocks. Small enclosures such as enclosure **108** in various form factors are commonly used for many electronic devices coupled to wires in a building driving the need for smaller terminal blocks, for example, such as a residential, commercial or industrial building security sensors and user interface panels; or for heating, ventilating and air-conditioning (HVAC) systems; or for machine control systems, or for smoke or fire detection systems.

[0032] FIG. **1B** shows a perspective view of a PCB mountable staggered terminal block of the present invention. The three-dimensional x-y-z axes are as shown. The x and y axes lie in the plane of the PCB with the x-axis oriented along the length of the terminal block and the z-axis normal to the plane of the PCB. Terminal block **200** is configured such that screw heads **202** are positioned in cavities **203** along a reference line **204** that is parallel to the x-direction. Similarly, the cavities **203** each have a center point **205** which coincides with the center point of the screw heads **202.** However, center points **205** of the screw

heads **202** are staggered by offsets in the y-direction with respect to the reference line **204** in the x-axis direction. The reduced height combined with the staggered configuration of the terminal block **200** enables it to be readily inserted into the nonconductive housing **108** in an orientation such that the length-wise direction of the terminal block is parallel to the x-axis. This orientation is more convenient for the installer who must connect the wires since the wires can now be inserted from the end of the PCB rather than from the side. That is, the prior art terminal block **100** will not fit in the 1 inch diameter housing if rotated 90° to provide better wire installation access.

[0033] In addition, when a sensor package is mounted and recessed into a cavity in a wall, an end mounted terminal block provides much greater advantages to the installer since the wires can be inserted from the end of the PCB rather than from the side. In the present invention, four terminals are possible in an end mounted configuration, and less depth of the recess cavity is required as compared to the prior art.

[0034] FIG. **2A** shows a perspective view of the prior art terminal block **100** of FIG. **1A** with respect to a standard installer screwdriver **150** with a 1/8 inch (3.175 mm) wide blade **152**. The width **w1** of the screwdriver blade **152** is greater than the width **w2** of the screw heads **102.** The width **w2** typically corresponds to the width of the slots **101.** Therefore, it is necessary for the installer to use a special screwdriver with a blade designed for the width **w2** of the miniature screw heads **102.**

[0035] FIG. **2B** shows a perspective view of the terminal block **200** of the present invention of FIG. **1B** with respect to the standard installer screwdriver **150** with a 1/8 inch (3.175 mm) wide blade **152**. In this case, the width **w1** of the screwdriver blade **152** is less than or equal to the width **w2'** of the screw heads **202**. The staggered positions of the screw heads **202** enable the screw heads **202** to have a width **w2'** that is at least equal to and typically greater than the width **w1** of the screwdriver blade **152.** Therefore, the installer can now use the standard screwdriver **150** with a blade **152** because the width **w1** of the screwdriver blade **152** is now less than or equal to the width **w2'** of the slot **201** of the screw heads **202**. Those skilled in the art recognize that the width **w2'** of the screw heads **202** enable usage also of screwdrivers with blade widths less than that of a 1/8 inch (3.175 mm) wide standard installer screwdriver.

[0036] FIG. **3A** shows a perspective view of the prior art terminal block **100** with the components fully assembled. As noted previously, the screw heads **102** are shown with a slot **101.** The slot **101** is typically 0.108 inches (2.7 mm) long and corresponds to the width **w2.** The spacing interval or pitch **p** between contact pins **110** in the x-direction is typically 0.138 inches (3.5 mm).

[0037] FIG. **3B** shows a perspective view of the terminal block **200** of the present invention with the components fully assembled. The screw heads **202** are shown with a slot **201** that corresponds to the width **w2'.** The slot **201** is typically 0.134 inch (3.4 mm) long. The spacing interval or pitch **p** between the contact pins **110**

is also typically 0.138 inches (3.5 mm) in the x-direction, yet staggered .075 inches (1.9 mm) in the y direction.

[0038] FIG. **4A** is an exploded perspective view of the prior art terminal block **100,** with the screws **112,** the terminal block housing **114,** transverse openings **115,** contacts **116** with pins or leads **110** and the wire guards **118.** The contacts **116** are accommodated within the transverse openings **115** of the terminal block housing **114.** A transverse opening **120** in each contact **116** enables the contact to accommodate one or more conductors (not shown). The screws **112** acting together with the contacts **116** with pins or leads **110** and the wire guards **118** form a screw-operated conductor clamping terminal means for clamping the conductors that are positioned within the transverse openings **120.** A conductive electrical path is formed from the conductors to the pins or leads **110** of the contacts **116.** The wire guards **118** act like washers by protecting the conductor wires from the rotation of the screw as the screws **112** clamp down on the wires.

[0039] FIG. **4B** is an exploded perspective view of the terminal block **200** of the present invention, which enables incorporation of the same wire guards **118** and the contacts **116** with pins or leads **110** and transverse openings **120.** However, the terminal block housing **214** is configured in a staggered arrangement by offsets in the y-direction along the x-axis to accommodate the screws **212.** The screws **212** have heads **202** as described previously with the slot **201** being typically a 0.134 inch (3.4 mm) long slot that corresponds to the width **w2'.** The screws **212** provide the same screw-operated means for clamping conductors as

described for the screws **112** in FIG. **4A.** The same contacts **116** are accommodated within the transverse openings **215** of the terminal block housing **214.**

[0040] FIG. **5A-1** is a plan view of the prior art terminal block **100** showing the housing **114** and the screw heads **102.** The screw heads **102** are configured to have a zero offset with respect to the x-direction reference line **104** and have a diameter $\phi 1$. The diameter $\phi 1$ corresponds typically to width **w2** of FIG. **2A**, and is typically 0.108 inches (2.7 mm). The dimension **Y1** is the depth of the housing **114,** which is typically 0.270 inches (6.9 mm). The dimension **X1** is the length of the housing **114,** which is typically 0.572 inches (14.5 mm).

[0041] FIG. **5B-1** is a plan view of the terminal block **200** showing the housing **214** and the screw heads **202.** In this case, the screw heads **202** are configured to have at least one offset **d** in the y-direction, i.e., **d = Y3,** with respect to the x-direction reference line **204** and have a diameter $\phi 2$. Typically, the diameter $\phi 2$ corresponds to **w2'** of FIG. **2B,** and typically is 0.134 inches (3.4 mm). The dimension **Y2** is the depth of the housing **214.** Despite the offset **d =Y3** and the larger diameter $\phi 2$ as compared to $\phi 1$, **Y2** is only 0.275 inches (7.0 mm). The dimension **X2** is the length of the housing **214.** Despite the offset and the larger diameter $\phi 2$ as compared to $\phi 1$, **X2** is only 0.576 inches (14.6 mm). As a result, the "foot-print" or area **A2** formed by the dimensions **X2 x Y2,** i.e., 0.15840 in^2 (102.19 mm^2), is virtually equal to the area **A1** formed by the dimensions **X1 x Y1**, i.e., 0.15444 in^2 (99.64 mm^2), so despite the staggering of the cavities **203**, the

foot-print remains virtually the same as in the prior art. In addition, terminal blocks that employ other types of screws such as, for example, Phillips head or Allen wrench head type screws, can also be arranged with staggered screw cavities as shown. Correspondingly, the diameter of such screw heads and of their respective screwdriver blades or wrench teeth can be larger than permissible with the prior art configuration of the terminal blocks while maintaining essentially the same footprint.

[0042] FIG. **5A-2** is an elevation view of the prior art terminal block **100** showing the housing **114** having a height dimension **Z1.** FIG. **5A-3** is a side elevation view of the terminal block **100** showing the housing **114** of the prior art. Typically, **Z1** is 0.335 inches (8.5 mm). The spacing interval **X3** or pitch **p** between the contact pins **110** is typically 0.138 inches (3.5 mm).

[0043] FIG. **5B-2** is an elevation view of the terminal block **200** of the present invention showing the housing **214** having a height dimension **Z2.** FIG. **5B-3** is a side elevation view of the terminal block **200** showing the housing **214** of the present invention.

[0044] In the present invention, due to the removal of the recessed screw retention features at the top of the screw cavities **203, Z2** typically is only 0.261 inches (6.6 mm). The spacing interval **X3** or pitch **p** between the contact pins **110** can remain the same as in the prior art, and is typically 0.138 inches (3.5 mm).

[0045] In a terminal block embodiment of the present invention, which contains typical screw retention features, the height **Z2** would remain the same as the prior art, i.e., **Z1** = **Z2**. These retention features typically take the form of deeper counterbores in the housing which have a slight interference fit with the screw heads. These counterbores are typically of sufficient length to maintain interference with the screw heads when the screws threads are completely disengaged from the contacts, thereby preventing the screws from being removed inadvertently.

[0046] By removing the screw retention features, the terminal block **200** affords a lower profile, as exemplified by dimension **Z2,** as compared to dimension **Z1** of the terminal block **100,** i.e., 0.261 in. (6.6 mm) as compared to 0.335 in. (8.5 mm). The lower profile affords additional degrees of freedom in orienting the terminal block **200** with respect to the nonconductive housing **108.** This is exemplified in FIG. **1B** where the longitudinal direction, i.e., the x-direction, of the terminal block **200** is oriented transversely with respect to the centerline longitudinal axis of the cylindrical non-conductive housing **108.** Therefore, the terminal block **200** is oriented 90° with respect to the terminal block **100** of the prior art as shown in FIG. **1A.**

[0047] The prior art terminal block **100** in FIG. **1A** must be oriented with the length-wise axis parallel to the axis of the cylindrical housing **108** since it will not fit within the housing if rotated 90°. The disadvantage of this orientation is that an installer must insert the conductor wires into the terminal block receptacles

over the top of other PCB mounted components, which makes the installation difficult. In the sensor housing shown in FIG. **1B**, the conductor wires are easily accessible. By eliminating the screw retention features, it becomes possible therefore to orient the terminal block **200** as shown in FIG. **1B** to make the conductor wires easily accessible.

[0048] The typical dimensions of a terminal block both the prior art and of the present invention are shown in the table which follows below.

TYPICAL DIMENSIONS PRIOR ART			**TYPICAL DIMENSIONS PRESENT INVENTION**		
Dimension	**in.**	**mm**	**Dimension**	**in.**	**mm**
X1	0.572	14.5	**X2**	0.576	14.6
X3 (=p)	0.138	3.5	**X3 (=p)**	0.138	3.5
Y1	0.270	6.9	**Y2**	0.275	7.0
Y3	0	0	**Y3**	0.075	1.9
***ϕ1* (or w2)**	0.108	2.7	***ϕ2* (or w2')**	0.134	3.4
A1= X1 x Y1	0.15444 in^2	100.05 mm^2	**A2= X2 x Y2**	0.1580 in^2	102.20 mm^2
Z1	0.335	8.5	**Z2**	0.261	6.6

[0049] Those skilled in the art recognize that the dimensions of **X2, Y2, Z2** and offsets represented by Y3 **(=d)** are not limited and can be varied as desired. Similarly, the spacing interval or pitch **X3 (= p)** can also be varied as desired.

[0050] Although the contacts **116** described in FIGS. **1B** through **5B-3** for the present invention include pins **110** for a "through hole" PCB attachment, an alternate embodiment can be configured for a surface mount (SMD) configuration. In such a case, terminal block **200** includes solder pads (not shown) permitting surface mounting to a printed circuit board (PCB).

[0051] Those skilled in the art recognize that the screw-operated coupling means for clamping a conductor as discussed for FIGS. **4A** and **4B** are used with wire conductors which typically have approximately the last 0.25 inches (6.4 mm) of insulation removed prior to inserting the conductor into the terminal block receptacle. An alternate embodiment (not shown) is a screw-operated insulation displacement terminal coupling means in which the conductor ends are not stripped, and the lower ends or terminals of the screws **212** pierce or displace the conductor insulation making contact with the conductor wire.

[0052] The invention has been described herein with reference to particular exemplary embodiments. Certain alterations and modifications may be apparent to those skilled in the art, without departing from the scope of the invention. The exemplary embodiments are meant to be illustrative, not limiting of the scope of the invention, which is defined by the appended claims.